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中国鹅膏菌属（担子菌）的物种多样性*

杨祝良
（中国科学院昆明植物研究所，云南 昆明　650204）

摘要：鹅膏菌属（*Amanita*）是一个近世界性广布的大属，全球已被描述而又被承认的有近 500 种。在文献中，我国此属已记载约 100 种。然而，许多种都是原初描述于欧洲或北美的种类。近来的研究表明，东亚的鹅膏菌独特且有其自身的分布范围。东亚的有些种虽与产于欧洲或北美的某些种相似，但仔细的野外观察、详尽的形态解剖学和分子进化生物学研究结果表明，东亚的鹅膏菌是独立的分类群。在欧洲，人们有采集著名食菌恺撒鹅膏菌的习惯；在东亚，人们采食的“恺撒鹅膏菌”实为红黄鹅膏菌及其近缘种。在欧洲，有剧毒的毒鹅膏菌、鳞柄毒鹅膏菌和春生毒鹅膏菌，而在东亚，每年夏秋出现的烟色毒鹅膏菌、黄盖毒鹅膏菌及其白色变种等，常引起严重的中毒事故，甚至导致人员死亡。在鹅膏菌属中，泛北极、欧亚或东亚－北美广布的种并不多见。东亚－北美鹅膏菌的生物地理联系通过地理替代种比通过相同分类群更能明确反映出来。该属目前下分为 2 亚属 7 组，每组在中国皆有多种代表。大多数鹅膏菌与乔灌木形成专性菌根关系，但在我国西南高海拔山区草地上出现的几种鹅膏菌可能并不形成菌根。此外，在我国不少鹅膏菌尚未研究和命名。因此，有理由认为中国的鹅膏菌是十分多样的。

关键词：真菌；担子菌；鹅膏菌；分类；物种多样性；生物地理学；中国
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Species Diversity of the Genus *Amanita*（Basidiomycetes）in China

YANG Zhu－Liang
（*Kunming Institue of Botany*，*The Chinese Academy of Sciences*，Kunming 650204）

Abstract：The subcosmopolitan genus *Amanita* consists of nearly 500 species described and accepted worldwide. In the literature about 100 taxa of the genus were reported in China. However，many of them were originally described in Europe or in North America. Recent studies have indicated that Amanitae in East Asia are unique and have their own geographical ranges. Although some species found in East Asia are similar to those occurring in Europe，or in North America，careful observations in the field，detailed morphological，anatomical study and molecular analysis show that the mushrooms in East Asia are distinct taxa. In Europe people gather the famous edible Caesar's Mushroom，namely *A*. *caesarea*，while in East Asia *A*.

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hemibapha and related taxa，which have usually been treated as *A. caesarea*，are often collected as food. In Europe the lethally poisonous mushrooms，i. e. the Death Cap（*A. phalloides*），the Destroying Angel（*A. virosa*），and the Spring Poisonous Mushroom（*A. verna*），occur，while in East Asia summer and fall fruiting mushrooms like *A. fuliginea*，*A. subjunquillea*，*A. subjunquillea* var. *alba*，also cause dramatic poisonings or even deaths every year. Holarctic taxa，European－Asian or North American－East Asian taxa are uncommon in this genus. The biogeographic relationships between *Amanita* of East Asia and North America are much more clearly reflected by vicarious species than by conspecific taxa. The genus is presently divided into 2 subgenera and 7 sections. All sections are well－represented in China. Most Amanitae obligately form ectomycorrhizae with trees or shrubs；however，fruiting bodies of a few species have been found in open fields at high elevations in southwestern China——probably forming no myccorhizae. In addition，an unknown number of taxa of the genus *Amanita* in China have yet to be studied and named. Hence，it is reasonable to conclude that Amanitae in China are very diverse.

Key words：Fungi；Basidiomycetes；*Amanita*；Taxonomy；Species diversity；Biogeography；China

The biodiversity of fungi in China remains poorly known because less attention has been given the them than to higher plants. The genus *Amanita* Pers.（Fungi，Basidiomycetes）is such an example. *Amanita* is an almost cosmopolitan genus，consisting of nearly 500 described and accepted species. Species of this genus are important to mankind because some of them are edible，while others are poisonous，or even lethal. Presently they appear to be even more valuable and important to us due to their mycorrhizal relationship with vascular plants and important role in ecosystems. Due to these facts，many collections of *Amanita* were made in China in the past hundred years and studied by many mycologists at home and abroad（Patouillard，1895；Teng，1936；Lohwag，1937；Chiu，1948；Wang，1973；Tai，1979；Peng *et al*.，1981；Horak，1987；Mao，1990；Yang，1994 & 1997）. While numerous species were reported from China，a quantity of them were originally determined as European or North American mushrooms. It is still uncertain whether such European or North American taxa indeed occur in China. In the vast territory of China many kinds of vegetation are distributed，ranging from tropical，subtropical to temperate zones，and consisting of many endemic plants. Abundant，varied，and characteristic fungi，including Amanitae，should occur in these diverse ecosystems. In order to understand the species diversity of *Amanita* in China，critical re－examinations of the vouchers，personal collection，comparative studies of recently collected specimens using modern techniques，and literature consultation are necessary.

1 Materials and Methods

Academic taxonomic reports on *Amanita* from China were collected and analyzed. An attempt was made to check doubtful identification by checking the original specimens when possible. For accurate and detailed information on the color and habit as well as anatomy of fruiting bodies，fresh materials were collected，noted，photographed and illustrated by the author in the field. Then the fresh materials were dried as soon as possible using a mushroom dryer. Possible ectomycorrhizal hosts were recorded at the time of collecting. Anatomical studies of basidiocarps were conducted using a light microscope at 1000 × using 5% KOH or Melzers' solution. For comparison，materials of similar or closely related taxa collected from

Europe or North America were also studied with respect to traditional taxonomy and molecular biology (Yang, 1997; Weiss *et al*., 1998).

2　Results and Discussion

Although there is no comprehensive treatment of the Chinese *Amanita*, about 100 taxa (including species, subspecies, varieties and forms) were recorded in China in the mycological literature (Patouillard, 1895; Teng, 1936; Lohwag, 1937; Chiu, 1948; Mao, 1990; Bi *et al*., 1994; Yang, 1994; Ying *et al*., 1994; Zang *et al*., 1996; Bi *et al*. 1997; Huang *et al*., 1998). If one analyzes the names in the checklist of Chinese *Amanita*, one gets the impression that many species were originally named and described from Europe or from North America. Recent intensive collecting and taxonomic studies have demonstrated that many Chinese Amanitae do not conform to taxonomic concepts based on European or North American Amanitae (Yang, 1997; Weiss *et al*., 1998). Although the genus is almost cosmopolitan, many species in the genus are confined to certain regions. According to Yang (1997), the genus *Amanita* may be divided into two subgenera and seven sections. All sections are well-represented in China. The features and species diversity of Chinese Amanitae are discussed according to the followings: (1) general features of the Chinese Amanitae; (2) European and Asian distribution; (3) disjunct distribution in East Asia and North America; (4) co-evolution of the Chinese Amanitae with their hosts.

2.1　General features of the Chinese Amanitae

The Amanitae in China are a main part of *Amanita* flora in East, Southeast and South Asia. The Amanitae in these regions are floristically linked in many ways. Several species occur only in this vast region, such as *A*. *hemibapha* (Berk. & Br.) Sacc., *A*. *rubrovolvata* Imai, *A*. *fritillaria* (Berk.) Sacc., *A*. *flavipes* Imai, etc. By comparison the Chinese Amanitae seem to have closer relationship with those in Japan and in South Korea than with those of other areas in the region, according to the present data. Many taxa, for instance, *A*. *rufoferruginea* Hongo, *A*. *sychnopyramis* f. *subannulata* Hongo, *A*. *virgineoides* Bas, and *A*. *japonica* Bas, described from Japan, also occur in China. On the other hand, in tropical or southern subtropical China, *Amanita* taxa show affinities to those in Southeast Asia. For example, *A*. *sculpta* Corner & Bas, *A*. *mira* Corner & Bas, *A*. *ovalispora* Boedijn, and *A*. *gymnopus* Corner & Bas, described from Southeast Asia have been also found in southern and southwestern China (Yang, 1997; Huang *et al*., 1998).

Several Amanitae have been found up to now only in southwestern China and its adjacent regions. They are *A*. *subfrostiana* Z. L. Yang, *A*. *chepangiana* Tulloss & Bhandary, *A*. *yuaniana* Z. L. Yang, *A*. *sinensis* Z. L. Yang, *A*. *atrofusca* Z. L. Yang, *A*. *brunneofuliginea* Z. L. Yang, *A*. *subglobosa* Z. L. Yang, etc. (Tulloss *et al*., 1992; Yang, 1997). It is still uncertain whether these species are endemic or not. Since Amanitae in Asia have not been studied extensively yet, more comprehensive floristic studies need to be undertaken in China and the neighboring countries before the true extent of endemism among Chinese *Amanita* can be determined.

Several unique species of *Amanita*, such as *A*. *tomentosivolva* Z. L. Yang, *A*. *verrucosivolva*

Z. L. Yang, and *A. sinensis* Z. L. Yang occur in southwestern China. They are systematically isolated in the genus because of the peculiar morphology and anatomy. They have probably evolved with the indigenous higher plants in the region. Such peculiar Amanitae (and other fungi) in China seem relatively common according to the author's unpublished data.

Floristico-geographycally, the Chinese Amanitae have much less of a connection with those of Europe, and of North America than previously thought. There are not many taxa common to both Europe and East Asia, to East Asia and North America, or widely distributed in Northern Hemisphere.

2.2 **European and Asian Distribution**

Many species of *Amanita* were believed to have broad intercontinental distribution. Some were considered holarctic or common both to (East) Asia and Europe. Recent critical studies showed that, in many cases, this not true. For instance, the Panther, *Amanita pantherina* (DC: Fr.) Krombh., was originally described from Europe (Veselý, 1933; Gilbert, 1940 & 1941). According to Lohwag (1937), Horak (1987), and many others, it occurs also in China. Recent examination of the voucher Handel-Mazzetti 1903 (WU 11025) showed that it consists of 2 fruiting bodies, each of which represents a species. Neither of them is *A. pantherina*. One fruiting body, named by the author as Handel-Mazzetti 1903a (WU 11025a), is an undescribed species. It differs from *A. pantherina* in its gray to grayish volval remains on the pileus and in fragile volval remnants on the base of stipe consisting of abundant inflated cells. The other fruiting body, named by the author as Handel-Mazzetti 1903b (WU 11025b), is a representative of *A. incarnatifolia* Z. L. Yang (Yang, 1997). Comparative studies of fungi attributed to *A. pantherina* from China clarified that the Chinese "*A. pantherina*" is not the true panther native to Europe.

Another example is the Caesar's Mushroom, *A. caesarea* (Scop.: Fr.) Pers., a well-known edible mushroom in Europe. This species was also reported from China by various mycologists (*e. g.* Teng, 1996; Bi *et al.*, 1997; Huang *et al.*, 1998). Critical examination of specimens treated as *A. caesarea* have revealed that they belong to the complex of *A. hemibapha*, a quite common group of taxa in East, South and Southeast Asia (Corner *et al.*, 1962; Hoiland *et al.*, 1982; Pegler, 1986; Imazeki *et al.*, 1988; Yang, 1997).

The fatally poisonous mushrooms, *i. e.*, the Death Cap [*A. phalloides* (Fr.) Link], the Destroying Angel (*A. virosa* Bertillon), and the Spring Poisonous Mushroom [*A. verna* (Bull.: Fr.) Lamarck] are fairly common in Europe (Veselý; Gilbert, 1940 & 1941; Garcin, 1984). Many people have become casualties after eating them (Wieland, 1973 & 1986). All three species were reported from East Asia, including China, South Korea and Japan (Imazeki *et al.*, 1979; Kim *et al.*, 1993; Imazeki *et al.*, 1988; Mao, 1991b). During the study of Chinese Amanitae, I have not found any typical, representative specimens of these species. However, similar taxa do occur in China. For example, *A. fuliginea* Hongo is a common, poisonous mushroom. It is widely distributed in China and Japan. It was probably mis-identified as *A. phalloides* by some Chinese mycologists. In addition, it is necessary to note that some collections of *A. pseudoporphyria* Hongo, and *A. manginiana sensu* Chiu from China were also often treated as *A. phalloides*. On the other hand, the white deadly poisonous mushrooms in

East Asia were often regarded as *A. virosa* or as *A. verna* (Imazeki *et al.*, 1988; Kim *et al.*, 1993; Teng, 1996). Critical examinations of collections identified as *A. virosa* and *A. verna* showed that there are at least two taxa in China and Japan, similar to, but not identical with the European *A. virosa* or *A. verna*. One is *A. subjunquillea* var. alba Z. L. Yang, whose relative, *A. subjunquillea* Imai, is fatally poisonous (Kawase *et al.*, 1992). *Amanita virosa* differs from *A. subjunquillea* var. *alba* in its irregularly formed, conical to campanulate pileus, thin and fragile annulus, and distinctly larger spores. Another one is *A. oberwinklerana* Yang & Doi. It possesses a scaly stipe, similar to that of *A. virosa*, and ellipsoid spors, similar to *A. verna*. For comparison of these species see Yang *et al.* (1999).

2.3 Disjunct Distribution in East Asia and North America

The disjunct distribution of congeneric higher plants between East Asia and (eastern) North America has been repeatedly discussed by botanists and evolutionary biologists since the time of Linnaeus (Boufford *et al.*, 1983). Such distribution patterns also draw the attention of mycologists (Wu *et al.*, 1997). However, since reliable works on taxonomic and systematic studies of fungi are not extensive enough, it seems to be too early to use the literature only to elucidate such floristic affinity. In the case of the distribution of a few *Amanita* species, misinterpretations seem to be present in the literature.

Amanita volvata (Peck) Lloyd was originally named and described from North America (Jenkins, 1986). It was frequently reported from East Asia (Teng, 1936; Imai, 1938; Hongo, 1982; Kim *et al.*, 1993), and supposed to be a representative of the North American and Eastern Asian disjunct distribution pattern (Wu *et al.*, 1997). Comparative studies of collections regarded as *A. volvata* from American and Chinese collections revealed that the Chinese material is not conspecific with that of the USA (Yang, 1997). In fact Imai (1933) has already published two species, namely *A. clarisquamosa* (Imai) Imai and *A. avellaneosquamosa* (Imai) Imai, to accommodate taxa in East Asia similar to *A. volvata*. These two species were supposed to be so closely related to *A. volvata* that they were usually treated as synonyms of the latter species (Hongo, 1959; Hongo, 1982). Morphological and anatomical studies of the types and/or additional collections of these three taxa showed that they are distinct species (Yang, 1997). Molecular data also suggest that they should not be treated as one taxon (Weiss *et al.*, 1998).

Although there are probably a few Amanitae, such as *A. farinosa* Schw., common both to East Asia and North America, the relationships between *Amanita* of East Asia and North America are much more clearly reflected by some vicarious species, according to morphological, anatomical, and in a few cases also molecular studies. For instance, *A. subfrostiana* described from southwestern China is very similar in morphology and anatomy to *A. frostiana* from North America (Yang, 1997). Phylogenetic analyses suggested sister group relationship (Weiss *et al.*, 1998). A few vicarious species may be listed here in Table 1.

Table 1 Vicarious species pairs between East Asia and North America

East Asia	North America
Amanita hemibapha (Berk. & Br.) Sacc.	*A. jacksonii* Pomerleau
A. subfrostiana Z. L. Yang	*A. frostiana* (Peck) Sacc.
A. clarisquamosa (Imai) Imai	*A. volvata* (Peck) Lloyd
A. alboflavescens Hongo	*A. crassifolia* Bas *nom. prov.*
A. cinereopannosa sensu M. S. Yuan	*A. cinereopannosa* Bas
A. sphaerobulbosa Hongo	*A. abrupta* Peck
A. sculpta Corner & Bas	*A. westii* (Murr.) Murr.
A. flavipes Imai	*A. flavoconia* Atk.

2.4 Co-evolution of the Chinese Amanitae with their hosts

Many Amanitae are associated with plants of the Pinaceae and Fagaceae by forming ectomycorrhizae. It is interesting to note that nearly 120 taxa of 9 genera of the Pinaceae are distributed in China (Ying, 1989). The vast region of Yunnan, Guangxi and Guangdong is the modern distribution center of Chinese fagaceous plants (Li, 1989). Forests with Pinaceae and/or Fagaceae plants provide ideal, diverse habitats for *Amanita* growth and fruiting. In return Amanitae assist the growth of higher plants. Several species were only found under trees or shrubs of the genus *Salix* in alpine mountains in southwestern China (Mao, 1991a; author's observations in northwest Yunnan). They seem to have been co-evolved with these plants during the formation of the Himalayas and the Hengduan Mountains.

In contrast, some species of *Amanita* may not form myccorhizae with higher plants (Bas, 1969). For example, a few species of *Amanita* were found in open fields with only several herbs, such as *Potentilla*, *Polygonum*, and *Cyperus*, mixed sometimes with scattered dwarf shrubs of *Berberis*, *Rhododendron*, or *Juniperus* in southwestern Yunnan at 4300 m elevation. Plants in such genera usually form no ectomycorrhizae with fungi. Amanitae occurring in such areas may have lost dependence on their hosts during the uplifting of the mountains.

3 Conclusion

According to field investigations, there is a large diversity of *Amanita* in China, which play special roles in ecosystems. However, many of them have yet to be studied and named. The European or North American Amanitae rarely occur in East Asia. Data about the diversity of Chinese *Amanita* at specific as well as infraspecific levels, such as variation in populations, are still incomplete. Information on variation expressed by individuals is much more scant. Little is known about the genetic/molecular diversity. More research should be carried out, in order to characterize the biodiversity of Chinese fungi, including Amanitae.

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References

Bas C，1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella* 〔J〕. *Persoonia*，**5**：285～579

Bi Z S，Li T H，Zhang W M，*et al*.，1997. A Preliminary Agaric Flora of Hainan Province 〔M〕. Guangzhou：Guangdong Higher Education Press，1～388 (in Chinese)

Bi Z S，Zheng G Y，Li T H，1994. Macrofungus Flora of Guangdong Province 〔M〕. Guangzhou：Guangdong Science and Technology Press，1～879 (in Chinese)

Boufford D E，Spongberg S A，1983. Eastern Asian－Eastern North American phyto－geographical relationship——A history from the time of Linnaeus to the twentieth century 〔J〕. *Ann Missouri Bot Gard*，**70**：423～439

Chiu W F，1948. The Amanitaceae of Yunnan 〔J〕. *Sci Rept Natl Tsing Hua Univ Ser B*，*Biol & Psychol Sci*，**3** (3)：165～178

Corner E J H，Bas C，1962. The genus *Amanita* in Singapore and Malaya 〔J〕. *Persoonia*，**2**：241～304

Garcin R，1984. Les Amanites européennes 〔M〕. Marlioz：Fédération mycologique Dauphiné－Savoie，1～332

Gilbert E J，1940. Amanitaceae 〔J〕. *Iconographia Mycologica*，**27**，Suppl. 1 (1)：1～200

Gilbert E J，1941. Amanitaceae 〔J〕. *Iconographia Mycologica*，**27**，Suppl. 1 (2－3)：201～427，73 pl.

Hoiland K，Schumacher T，1982. Agarics，clavarioid and some heterobasidiomycetous fungi from northern Thailand 〔J〕. *Nord J Bot*，**2**：265～271

Hongo T，1959. The Agaricales of Japan I－ (1) 〔J〕. *Mem Fac Liberal Arts Shiga Univ*，*Pt*. 2，*Nat Sci*，**9**：47～94

Hongo T，1982. The Amanitas of Japan 〔J〕. *Acta Phytotax Geobot*，**33**：116～126 (in Japanese)

Horak E，1987. Boletales and Agaricales (fungi) from northern Yunnan，China I. Revision of material collected by H. Handel－Mazzetti (1914～1916) in Lijiang 〔J〕. *Acta Bot Yunnanica* (云南植物研究)，**9**：65～80

Huang N L，Ying J Z，Zang M，*et al*.，1998. Colored Illustrations of Macrofungi (Mushrooms) of China 〔M〕. Beijing：China Agricultural Press，1～293 (in Chinese)

Imai S，1933. Studies on the Agaricaceae of Japan I. Volvate agarics in Hokkaido 〔J〕. *Bot Mag* (Tokyo)，**47**：423～432

Imai S，1938. Studies on the Agaricaceae of Hokkaido I 〔J〕. *Journ Facul Agr Hokkaido Imp Univ Sapporo*，**43**：1～178

Imazeki R，Hongo T，1979. Coloured Illustrations of Fungi of Japan. Vol. 1. 〔M〕 Osaka：Hoikusha Publishing Co.，Ltd.，1～181 (in Japanese，first edition 1957，reprinted in 1979)

Imazeki R，Hongo T，1987. Colored Illustrations of Mushrooms of Japan. Vol. 1. 〔M〕 Osaka：Hoikusha Publishing Co.，Ltd.，1～325 (in Japanese)

Imazeki R，Otani Y，Hongo T，1988. Fungi of Japan 〔M〕. Tokyo：Yama－kei Publishers Co.，Ltd.，140～171 (in Japanese)

Jenkins D T，1986. *Amanita* of North America 〔M〕. Eureka：Mad River Press，1～198

Kawase I，Shirakawa H，Watanabe M，1992. Deaths caused by *Amanita subjunquillea* poisoning and the distribution of this mushroom in Hokkaido 〔J〕. *Trans Mycol Soc Japan*，**33**：107～110 (in Japanese)

Kim Y S，Suck S J，Park Y H，*et al*.，1993. *Amanita* in Korea 〔C〕. In：Proceedings of the First Korea－China Joint Seminar for Mycology (Seoul，Dec. 2－5，1993)，114～127

Li W Z，1989. Study on the geographical distribution and floristic geography of Fagaceae flora in Yunnan Province 〔J〕. *Trop Geogr*，**9**：265～270 (in Chinese)

Lohwag H，1937. Hymenomycetes 〔M〕. In：Handel－Mazzetti H，Hrg. Symbolae Sinicae (Band 2). Wien：Julius Springer，37～66

Mao X L，1990. Taxonomic study on the genus *Amanita* from Xizang，China 〔J〕. *Acta Mycol Sinica*，**9**：206～217 (in Chinese with English abstract)

Mao X L，1991a. Distribution patterns of *Amanita* in Xizang (Tibet) 〔J〕. Acta Mycol Sinica，**10**：288～295 (in Chinese with

English abstract)

Mao X L, 1991b. Poisonous mushrooms of Amanitaceae from China and their poisons 〔J〕. *Microbiol*, **18**: 160～165 (in Chinese)

Patouillard N, 1895. Enumération des champignons récoltés par les RR. PP. Farges et Soulié, dans le Thibet oriental et le Su-tchuen. *Bull Soc Mycol France*, **11**: 196～199

Pegler D N, 1986. Agaric Flora of Sri Lanka 〔J〕. *Kew Bull Addit Ser*, **12**: 1～519

Peng Y B, Liu L H, 1981. A new species of *Amanita* 〔*J*〕. *Acta Microbiol Sinica*, **21**: 152～153

Tai F L, 1979. Sylloge Fungorum Sinicorum 〔M〕. Beijing: Science Press, 1～1527 (in Chinese)

Teng S C, 1936. Additional fungi from China Ⅲ 〔J〕. *Sinensia*, **7**: 529～569

Teng S C, 1996. Fungi of China 〔M〕. Ithaca: Mycotaxon, Ltd., 1～586

Tulloss R E, Bhandary H R, 1992. *Amanita chepangiana* - a new species from Nepal 〔J〕. *Mycotaxon*, **43**: 25～31

Veselȳ R, 1933. Revisio critica *Amanitarum* europaearum 〔J〕. *Ann Mycol*, **31**: 209～298

Wang Y Z, 1973. Two new species of Agaricales 〔J〕. *Acta Microbiol Sinica*, **13**: 7～10

Weiss M, Yang Z L, Oberwinkler F, 1998. Molecular phylogenetic studies in the genus *Amanita* 〔J〕. *Can J Bot*, **76**: 1170～1179

Wieland T, 1973. Ueber die Giftstoffe der Gattung *Amanita* 〔J〕. *Zeitschr f Pilzkunde*, **39**: 103～112

Wieland T, 1986. Peptides of poisonous *Amanita* mushrooms 〔M〕. New York, Berlin, Heidelberg: Springer-Verlag, 11～45

Wu Q X, Mueller G M, 1997. Biogeographic relationships between the macrofungi of temperate eastern Asia and eastern North America 〔J〕. *Can J Bot*, **75**: 2108～2116

Yang Z L, 1994. Studies of the genus *Amanita* from southwestern China (I) 〔J〕. *Mycotaxon*, **51**: 459～470

Yang Z L, 1997. Die *Amanita* - Arten von Suedwestchina 〔J〕. *Biblioth Mycol*, **170**: 1～240

Yang Z L, Doi Y, 1999. A contribution to the knowledge of *Amanita* (Amanitaceae, Agaricales) in Japan 〔J〕. *Bull Natn Sci Mus*, *Tokyo Ser. B*, **25** (3): 107～130

Ying T S, 1989. Areography of the gymnosperms of China (1) - Distribution of the Pinaceae of China 〔J〕. *Acta Phytotaxon Sinica*, **27**: 27～38 (in Chinese)

Ying J Z, Zang M, *et al*., 1994. Economic Macrofungi from Southwestern China 〔M〕. Beijing: Science Press, 1～399 (in Chinese)

Zang M, Li B, Xi J X, 1996. Fungi of the Hengduan Mountains 〔M〕. Beijing: Science Press, 1～598 (in Chinese)